Station Circular 48 July, 1923

Oregon Agricultural College

Experiment Station

The Cane Fruit Industry in Oregon

By

HENRY HARTMAN

CORVALLIS, OREGON

The regular bulletins of the Station are sent free to the residents of Oregon who request them.

BOARD OF REGENTS OF THE OREGON AGRICULTURAL COLLEGE AND EXPERIMENT STATION

Hon. J. K. Weatherford, President	Albany
Hon. N. R. Moore, Secretary	Corvallis
Hon. B. F. Irvine, Treasurer	Portland
Hon. Walter M. Pierce, Governor	Salem
Hon. Sam A. Kozer, Secretary of State	Salem
Hon. J. A. Churchill, Superintendent of Public Instruction	Salem
Hon. Charles E. Spence, Master of State Grange	Oregon City
Hon. C. L. Hawley	Portland
Hon. Thomas H. Crawford	LaGrande
Hon. Harry Bailey	Lakeview
Hon. Geo. M. Cornwall	Portland
Hon. Jefferson Myers	Portland
Hon. M. S. Woodcock	Corvallis

STATION STAFF

W. J. Kerr, D.Sc., LL.D.	President
J. T. Jardine, B.Sc.	Director
E. T. Reed, B.Sc., A.B.	Editor
H. P. Barss, A.B., S.M.	Plant Pathologist
P. M. Brandt, B.Sc., A.M.	Dairy Husbandman
A. G. Bouquet, B.Sc.	Horticulturist (Vegetable Gardening)
G. G. Brown, B.Sc.	Horticulturist, Hood River Br. Exp. Station, Hood River
W. S. Brown, A.B., M.S.	Horticulturist in Charge
D. E. Bullis, B.Sc.	Assistant Chemist
Leroy Childs, A.B.	Supt. Hood River Branch Exp. Station, Hood River
G. V. Copson, M.S.	Bacteriologist
H. K. Dean, B.Sc.	Supt. Umatilla Branch Exp. Station, Hermiston
A. E. Engbretson, B.Sc.	Supt. John Jacob Astor Br. Exp. Station, Astoria
B. B. Fulton, B.A., M.S.	Associate Entomologist
W. V. Halversen, M.S.	Assistant Bacteriologist
H. Hartman, M.S.	Assistant Horticulturist (Pomology)
E. M. Harvey, Ph.D.	Horticulturist (Physiology)
Harry Humfeld	Assistant to Supt. of Umatilla Branch Station, Hermiston
G. R. Hyslop, B.Sc.	Farm Crop Specialist
W. W. Johnston, B.Sc.	Assistant in Soils (Irrigation)
J. S. Jones, M.S.	Chemist
R. C. Jones, B.Sc.	Associate Dairy Husbandman
F. L. Knowlton, B.Sc.	Assistant Poultry Husbandman
J. C. Lewis	Farm Crop Foreman
A. L. Lovett, B.Sc.	Entomologist
A. G. Lunn, B.Sc.	Poultry Husbandman in Charge
F. W. Miller, M.S., D.V.M.	Assistant Veterinarian
H. G. Miller, Ph.D.	Associate Chemist
G. A. Mitchell, B.Sc.	Asst. to Supt. of Sherman County Branch Station
M. B. McKay, M.S.	Associate Plant Pathologist
O. M. Nelson, B.Sc.	Associate Animal Husbandman
J. R. Nevius, B.Sc.	Assistant Farm Crop Specialist
R. K. Norris	Assistant to Supt. of Southern Oregon Branch Station, Talent
A. W. Oliver, B.Sc.	Assistant Animal Husbandman
E. L. Potter, M. S.	Animal Husbandman
W. L. Powers, M.S.	Chief, Department of Soils
F. C. Reimer, M.S.	Supt. Southern Oregon Br. Exp. Station, Talent
R. H. Robinson, M.S.	Associate Chemist
C. C. Ruth, M.S.	Assistant Farm Crop Specialist
C. V. Ruzek, B.Sc.	Associate in Soils (Fertility)
Bertha M. Hite	Scientific Asst. Seed Lab. U. S. Dept. of Agri. (Seed Analyst)
H. A. Schoth, M.S.	Scientific Asst. in Forage Crops, U. S. Dept. of Agri.
C. E. Schuster, M.S.	Assistant Horticulturist (Pomology)
H. D. Scudder, B.Sc.	Chief in Farm Management
O. Shattuck, M.S.	Supt. Harney County Branch Exp. Station, Burns
B. T. Simms, B.Sc., D.V.M.	Veterinarian
D. E. Stephens, B.Sc.	Supt. Sherman County Br. Exp. Station, Moro
R. E. Stephenson, Ph.D.	Associate Soils Specialist
E. F. Torgerson, B.Sc.	Assistant in Soils (Soils Survey)
E. H. Wiegand, B.Sc.	Horticulturist (Horticultural Products)
Robert Withycombe, B.Sc.	Supt. Eastern Oregon Br. Exp. Station, Union
H. M. Woolman, Field Asst., Office of Cereal Investigations, U. S. Dept. of Agri.	
Willard W. Yates, B.Sc.	Assistant Chemist
S. M. Zeller, Ph.D.	Associate Plant Pathologist

The Cane Fruit Industry in Oregon

By

HENRY HARTMAN

The cane fruit industry constitutes one of the important branches of Oregon horticulture. The report of the State Tax Commission for 1921 shows that at that time an area of 8,710.67 acres was devoted to the culture of these fruits in this state. Plantings since 1921 bring the present total to approximately 10,000 acres, this to be compared with about 100,000 acres for the entire United States. Though these fruits are grown to some extent in practically all parts of Western Oregon, their commercial culture is confined primarily to the Willamette Valley, the major portion of the acreage being found in the counties of Marion, Yamhill, Multnomah, Columbia, Clackamas, Washington, Lane, Linn, and Polk.

The past ten years have witnessed a phenomenal increase in the plantings of cane fruits in Oregon, but a slight decrease for the United States as a whole. From 1919 to 1921, for example, the area given over to the culture of these fruits in this state was increased by 5,050.69 acres. Figures from the census report for the entire country, on the other hand, show a decrease in plantings of approximately 2,000 acres during the ten-year period.

The recent plantings of cane fruits in this state have been more or less disproportionate, with the result that at the close of 1921 plantings of the loganberry totaled 6,259.27 acres while the acreage of all the other cane fruits combined was only 2,451.40 acres. Had these fruits been planted in more equal proportions there is little doubt that the industry would now be on a more secure foundation. Greater diversity in plantings would enable the selling agencies better to meet the demands of the trade, would result in a better distribution of the grower's labor, and would insure a better-balanced seasonal run for the various processing concerns.

A considerable area in Oregon as well as in neighboring states is suited to the culture of cane fruits, and it is certain that the potential production of these fruits in this region is far in excess of present market demands. Future plantings, therefore, should be guided primarily by present and future market conditions. Western cane fruit growers must realize that to a large extent the producer is a servant of the consumer, that he must grow what the consumer wants and must grow only so much as the consumer can be induced to buy. There is a vigorous demand at the present time for raspberries and blackberries, but it is decidedly bad economics to assume that this demand is unlimited and that wholesale planting is thereby justified. With the increasing demand for canned goods and other horticultural products, however, there is ground for belief that the cane fruit industry here will not only hold its own but will undergo some expansion in the future.

YIELDS

The yields of cane fruits in Western Oregon vary greatly between individual yards and between seasons. Loganberry yields per acre fluctuate between one and six tons, Evergreen blackberries between two and seven tons, red raspberries between one and five tons, and black raspberries between three-fourths and four tons. Figures on the cost of production indicate quite clearly that financial returns from cane fruits are directly associated with yields. Recent statistics on red raspberry production in the Puyallup Valley of Washington show that in cases wherein yields are 3000 pounds per acre the cost of production per pound is slightly more than twice as high as in cases where a yield of 8000 pounds is obtained. The lesson from these figures is clear. Maximum yields reduce the cost per unit and may result in a profitable margin below sales prices, while a low yield may actually show a loss per unit at the same sales figures. Overhead expenses such as taxes, interest on money invested and the cost of spraying, pruning, training, cultivation, etc., are practically the same regardless of whether yields are high or low, and it is false reasoning to assume that low yields can be made up by merely increasing the acreage. A study of cane fruit plantings in this region makes the fact plain that differences in yields are due not only to differences in soil and climate but also to the personal element in the management of the yards.

LOCATION

It is obvious that in selecting the location for a cane fruit plantation such factors as the distance to market or processing plants, the nature of the roads, the climatic conditions, the labor problem, the financial situation, the possibility for irrigation, the prevalence of insects and disease and the general status of the industry in the locality must be taken into account. Cane fruits are extremely perishable products. They must be handled with care and within a comparatively short period of time. Consequently, the matter of sufficient labor, transportation, and general facilities for handling and disposing of the crop should be investigated thoroughly.

SITE OF THE PLANTATION

In the selection of a site, soil type, moisture supply, temperature, and drainage are important factors.

Cane fruits are naturally sensitive to the dry, warm heat of summer, and in some seasons much damage results from this source. Considerable of the trouble known as "seediness" can be ascribed to excessive temperatures. Cool situations, therefore, should be selected whenever possible. River bottoms and north slopes are naturally cooler and can be kept more moist during the growing season. A little care in the selection of the site does much to increase the yield and improve the quality of the fruit, especially that of the later pickings.

The matter of air drainage is not as vital with the cane fruits as with the tree fruits. Cane fruits as a class are late bloomers and their blossoms are not so apt to suffer from spring frost. It is a poor policy, however, to plant these fruits in situations that are known to be frosty, for the new cane growth often suffers from cold.

The matter of water drainage should receive attention. Due primarily to the mild winters of this region the roots of cane fruits are more or less active during the winter months, and consequently, must not be under water for any considerable period of time. Loganberries on the Experiment Station grounds have shown repeated root injury due to the wet condition of the soil in which they were grown. Artificial drainage has been successful in some cases; however, it is best whenever possible to select land that drains of its own accord.

SOILS FOR THE CANE FRUITS

A survey of the plantings of cane fruits in this region would reveal that these fruits are being grown on a wide range of soil. While this is true the successful culture of cane fruits in this state is limited to rather definite soil types. Low yields, seedy berries, and poor cane growth can in many cases be associated with poor choice of soil. Red hill land which has proved so well suited to many of the tree fruits does not seem to be universally adapted to the cane fruits. This is also true of the flat white land common in many parts of Western Oregon. Cane fruits should never be planted in tight, poorly drained, clay loams. These fruits, in general, do well in soil that is deep, cool, rich, friable, well drained, and at the same time retentive of moisture. The slightly rolling river bottom soils seem to be ideal for them. Sandy loam is well adapted to red raspberries provided moisture is sufficient. Evergreen blackberries seem to do well in the lighter types of clay loam, but it is a mistake to attempt even these on heavy non-workable land.

VARIETIES

The botanical genus Rubus, to which the cane fruits belong, is a variable and perplexing group. Modern plant classifications admit perhaps four hundred well defined species and numberless intermediate forms. Wild cane fruits are found in most of the countries of the north temperate zone. Hundreds of horticultural varieties of these have been named, described, and introduced. About 140 varieties of blackberries alone have found their way into American pomology.

Commercial culture of these fruits in Oregon, however, is confined to a relatively small number of varieties. Experience has shown that the trade is rather reluctant in accepting new varieties. Consequently, the commercial grower finds it to his advantage to confine himself to a few well tried sorts that give big yields, that can be successfully handled, and that meet the requirements of the trade.

Red Raspberries. Cuthbert seems to be the only variety of red raspberry that has stood the test of time in Oregon. This variety, while only a moderate producer, is admirably adapted to both the canning and fresh fruit trade. Marlboro, while a thrifty grower and a heavy yielder, does not have sufficient quality to compete with Cuthbert. King seems to be fairly well suited to the heavier types of land, but this variety is not a favorite with the trade. Antwerp is a heavy yielder but does not as a rule hold up well. The so-called Everbearing raspberries, while perhaps of some value for home plantings, are not suitable to commercial culture.

Black Raspberries. Plum Farmer and Munger black raspberries are most in demand at this time. Plum Farmer is a vigorous and productive

variety. Munger seems to be only moderately thrifty but is fairly productive. Cumberland is a strong grower, does fairly well for canning, and is receiving attention in some quarters. Gregg is a late-season sort which bears well but is rather tender to cold. It is excellent for home use and for the local market, but it crumbles too easily to be a favorite with canners.

Loganberries. Loganberry is the only variety of its class that has established itself here. Primus and Phenomenal have not been able to compete with it. The fruits of both are somewhat softer in texture, and Phenomenal, in particular, has a tendency to produce many imperfect fruits; and, besides, its vines do not seem to be long lived.

Blackberries. Evergreen seems to be the only blackberry that meets with the approval of both the growers and the trade in this state. This variety is vigorous and unusually productive, is easy to handle, and fills the requirements of cannerymen. Mammoth and Cory Thornless, while excellent for home and local use, have not proved generally desirable for commercial planting. Cory Thornless, a bud sport of Mammoth, seemingly has a tendency to revert to the thorny condition after a few years in the plantation. Lawton, Eldorado, and other favorites in the eastern states have only a limited demand in Oregon.

Other Canes. Dewberries and the purple-caned raspberries have not been money makers in this region. Both, however, seem to be well adapted from the cultural standpoint, but the trade seemingly is but little interested in them.

Some of the old favorite varieties will doubtless be supplanted by newer ones as time goes on, but any new sort must undergo a severe test before growers are justified in attempting it on a large scale.

POLLINATION

Most cane fruits are apparently self-fertile under Oregon conditions, and the matter of cross-pollination is therefore of little importance. Mammoth and Cory Thornless blackberries, however, appear to be more or less self-sterile and require cross-pollination. Insufficient cross-pollination of these not only reduces the total set, but results in imperfect fruits. Evergreen blackberry seems to be a satisfactory pollenizer for both of these varieties.

PROPAGATION

Plants of the various cane fruits are obtained from regular nurseries or are propagated by the growers themselves. The mild and moist winters of Western Oregon render the propagation of these fruits a comparatively easy matter. Since insects and diseases are becoming more and more a factor in the culture of cane fruits one should, so far as possible, select young plants only from yards that are clean and free from troubles.

From Tips. New plants of loganberry, the black raspberry, the Cory Thornless and Mammoth blackberry, the purple-caned raspberry, as well as the dewberry, start readily from the tips of the new shoots. For this purpose, the growing tips of the shoots should be imbedded in soil from

two and one-half to three inches, just before the fall rains begin. Merely covering the tips with loose earth is sufficient. To insure success, they should be set into a slit or narrow trench made with a shovel; following this, the soil should be thoroughly "firmed" about them. By the following spring, the tips should have developed good root systems and may then be severed, leaving from four to eight inches of the cane with the new plants, which are ready for setting in the field. A larger number of plants can be secured by covering the entire cane and causing roots to come out at the joints or nodes. Plants thus produced, however, are less vigorous than are those grown from tips and are not to be generally recommended.

From Suckers. Red raspberries send up new canes from the base of the old ones. They send up, in addition, suckers from underground roots at various distances from the crown of the parent plant. All these, when properly rooted, make satisfactory new plants. If one intends to grow plants for sale, it may be advisable to devote a part of the field to this purpose, in which case the old vines should be grubbed up and removed. By the following year, a solid stand of new plants suitable for setting will have sprung up from the pieces of roots left in the ground. Due to the fact that considerable root growth takes place during the winter months, it is best to leave the young plants undisturbed until spring.

Evergreen and Himalaya blackberries are propagated either from suckers or root cuttings. These also grow from tips but do not root as readily by this method as do the black raspberries and others. Much of the stock for the commercial plantings of these varieties is obtained from the wild plants which are now so common in most of the western parts of the state. It must be borne in mind, however, that the wild forms of these sorts originate from the seed and consequently a certain amount of variation occurs among them. In the choice of new plants, therefore, one should select only from such parent plants as are known to be vigorous and productive of quality fruit. Some growers find it advantageous to grow the Evergreen plants in nursery rows for one season before setting in the field.

AGE OF FULL BEARING

The Evergreen blackberry, though a rank grower when once established, usually requires about five years to come into maximum production. Red and black raspberries commence fruiting the second year but require three to four years to reach full maturity. Loganberries require from four to five years to come into full bearing, but usually produce fair crops during the third and fourth seasons.

DURATION OF PLANTATION

The factors that determine the number of years a cane fruit plantation will last are not entirely understood, but when given proper attention and kept free from insect pests and diseases the cane fruits in this state seem to be unusually long-lived. Black and red raspberry plantings known to be fifteen and twenty years old are still thrifty and productive. Evergreen and Himalaya blackberries seem to last indefinitely. Loganberry plants twenty years old are still producing commercial crops.

ESTABLISHING THE PLANTATION

It is a generally accepted principle of plant physiology that the leaves of a plant must be exposed to sunlight before the food materials can be elaborated and made available for growth. Though the fruit itself does best in the shade, the leaves of cane fruits must be exposed to abundant sunlight if the plants are to be healthy and productive. Planting distance and planting systems should be determined with this fact in mind. Other factors to take into account are the strength of the soil, the vigor of the varieties, training systems to be used, cultural methods to be employed, and last but not least individual preference for this or that system.

The loganberry, Cory Thornless and Mammoth blackberries do well and can be handled with comparative ease when set on the square plan, 8 to 10 feet apart, 9 feet apart being a popular distance for average soil. The Evergreen blackberry can be readily handled when set in rows 7 to 8 feet apart with the plants 14 to 16 feet apart in the rows. Cuthbert red raspberry is now generally planted by the linear method, the rows being from 6 to 8 feet apart and the plants in the rows from 2 to 3 feet apart. King and Marlboro are slightly more vigorous than Cuthbert, and consequently should be set a little farther apart. The hill system does not lend itself to the cultural methods employed in Oregon. Black raspberries tend to spread out a little more and should be set somewhat farther apart than the reds. The linear system with the rows 7 to 9 feet apart and the plants about 4 feet in the rows is proving satisfactory with the common varieties.

Number of Plants per Acre. To find the number of plants required to set an acre multiply the distance between rows by the distance of the plants in the rows. This will give the number of square feet required for each plant or hill. Then divide this number into 43,560, the number of square feet in an acre.

Table I gives some of the common planting distances and the number of plants required per acre.

TABLE I. NUMBER OF PLANTS PER ACRE

Distances apart	Number of plants per acre
7 by 7 ft.	888
7 by 8 ft.	777
8 by 8 ft.	680
16 by 7 ft.	380
16 by 8 ft.	389
18 by 7 ft.	345
18 by 8 ft.	302
8 by 2½ ft.	2678
8 by 3 ft.	1848
8 by 4 ft.	1361

TILLAGE

Tillage in the cane fruit plantation should be done with the aim (1) of conserving the moisture and (2) of making the soil foods available. Frequent cultivation during the growing season is necessary in order that a loose earth mulch may be maintained at all times. A layer of dry earth 2 to 2½ inches deep is sufficient to break the passageways by means of which moisture may escape from the lower moist soil to the

air. It must be borne in mind, however, that the mulch soon loses its efficiency unless frequently renewed. Summer showers unless followed by tillage destroy the mulch. Hard, unpulverized ridges between the plants make the escape of moisture possible and tend to offset the value of a good mulch in the center of the rows. Even where irrigation is practiced tillage after each watering is necessary if the effects are to be preserved. Tillage every week or ten days is none too frequent during the summer months, especially during dry seasons.

The cane fruits as a class are more or less shallow rooted, with the result that at the beginning of each season a set of feeding roots is established in the upper portion of the soil. Shallow cultivation, therefore, is best during the summer months in order that these feeding roots may escape injury. Plowing, disking, and deep cultivation of any sort should be done only during the dormant season. Some growers find it a good practice in fall plowing to throw the earth toward the vines. This leaves the dead furrow in the center of the row, and the water is thus carried away from the plants.

Tools. The tractor seems to be a permanent fixture in the cane fruit plantings of this state, the small, reasonably cheap type being the most satisfactory. Two general types of tractors are now in use; namely, the track-laying or caterpillar type, and the wheel type. Since cultivation must be carried on in spite of the cane growth in summer the track-laying type is perhaps best. Tractors for the cane fruit growers must be convenient as well as serviceable. They must have the ability to make short turns and must be so constructed as not unduly to pack the soil. A tractor which will pull two 14-inch or three 10-inch bottoms is sufficiently powerful for general use. Larger size means waste of power, especially in the lighter operations of cultivation.

Cultivation tools should be selected for the needs of the berry plants. Large tools should be so adjustable that they can be set more shallow near the plants. When tractors are employed the tandem reversible disk has proved itself to be a valuable tool. This disk can be so adjusted that the gangs throw the earth either in or out. An efficient tool to follow the reversible disk after the disking has been thoroughly done is a combination plank level and Kimball weeder, the weeder being set between the sides of the planks (Fig. 1). This tool thoroughly pulverizes the surface soil, keeps down weeds, and aids in maintaining the field level. Another valuable tool in the cane fruit plantation is the old fashioned grape hoe. This tool can be used near the plants, and aids materially in reducing the size of the ridges. No matter how complete the equipment of cultivation tools is, however, a certain amount of hand work is necessary around the plants. For this work there is perhaps no better tool than a common hoe of good size. In this operation care must be taken not simply to scrape off the weeds and leave the ground to dry, but rather to chop up the weeds and soil into a mulch, which will be effective in preserving the moisture.

SOIL FERTILITY

Soils vary greatly in the matter of plant food elements, and in terms of soil management each individual piece of ground is a problem unto itself. Consequently, in a publication of this nature only general recommendations can be made concerning the matter of fertility.

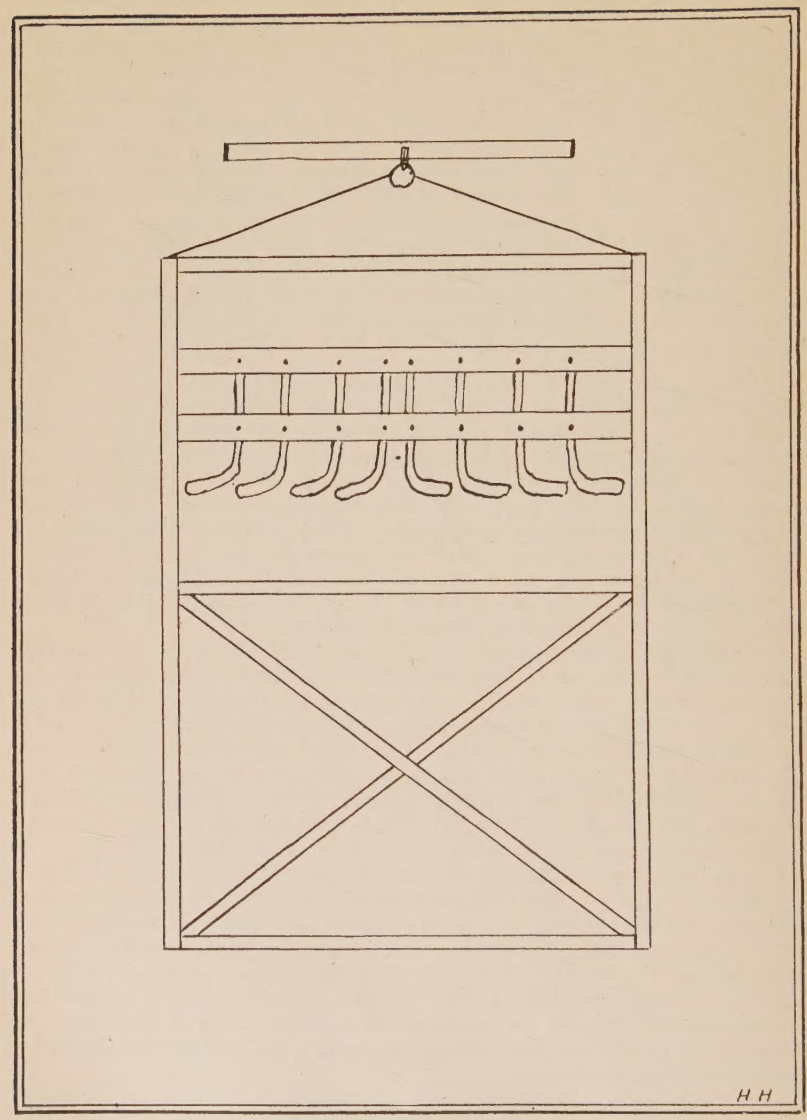

Fig. 1. A combination of the plank level and the Kimball weeder makes an excellent tool to eradicate weeds and pulverize the top soil.

There are ten elements or materials necessary for the successful growth of plants. These are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and iron. Carbon, hydrogen, and oxygen are usually available in unlimited quantities from the air and water and make up approximately 95 percent of the plant structure, including its crop. Calcium, magnesium, and iron are used only in very small amounts and seemingly most of the soils of this state are sufficiently supplied with these. Phosphorus, potash, and sulfur are used by plants in liberal amounts and in some cases must be supplied. The remaining element, nitrogen, is furnished largely by the organic matter and along with the organic matter is usually the first plant food to disappear from Western Oregon soil. Deficiency of this element in available form undoubtedly contributes to limited cane growth and yields.

Loss of Plant Food Elements. The continued removal of crops and the loss due to drainage and leaching, as well as that due to natural decomposition, invariably reduce the soil's store of plant food. Experiments have shown that the apple trees on one acre remove nitrogen equal to that carried by 340 pounds of nitrate of soda, phosphoric acid equal to that carried by 95 pounds of 16 percent superphosphate, and potash equal to that carried by 135 pounds of sulfate of potash. Losses from causes other than crop removal bring the total considerably higher, so that it is fairly safe to assume that the annual depletion from an acre of cane fruits is equal to that of 1200 pounds of nitrate of soda, 280 pounds of 16 percent superphosphate, and 190 pounds of high-quality sulfate of potash. Obviously any system of soil management that will insure a permanent agriculture must make plant food elements not only available for the moment but must compensate for the continual loss due to natural agencies and to crop removal. It is far more economical in the long run to maintain soil fertility from year to year than it is to wait until the soil has ceased to be productive.

Soil Needs Organic Matter. Organic matter returns to the soil the same elements that are removed by crops, improves the physical properties, promotes necessary bacterial and chemical action and makes the soil more retentive of moisture. Commercial fertilizers, while helpful as accessories, cannot completely replace organic material. Much of the soil now devoted to the culture of cane fruits has been under cultivation for many years and has lost a considerable portion of its organic matter. The paramount problem of the cane fruit grower so far as soil fertility is concerned is the finding of an economical method of replacing the depleted organic matter and then maintaining it.

Soil lacking in organic matter is usually characterized by light color, stickiness when wet and compactness when dry. Cane fruits on this soil are marked by the lack of good green color, spindling growth, and fruit that is small and seedy.

Methods of Supplying Organic Matter. A feasible and practical means of replenishing and maintaining the organic matter is that of cover crops. Due to the comparatively mild winters of this region, such cover crops as barley and common vetch *(V. sativa)* can be made to produce a considerable amount of organic matter during the winter months. Common vetch, being a leguminous plant, has the power to

make free nitrogen from the air available for growth. Crops for this purpose should be sown before the fall rains begin at the rate of 30 to 40 pounds of vetch and 25 to 30 pounds of barley per acre. These crops should be turned under in spring. Whenever possible, these should be drilled in rather than broadcasted, this practice resulting in better germination and less injury from drought. It is a mistake to leave cover crops standing too long, for they tend to become woody, do not decay well, and soon deplete the soil of moisture.

A second method of replacing humus is that of applying manure, straw, or other crop refuse. A ton of wheat straw contains as much nitrogen as 62½ pounds of nitrate of soda, as much phosphorus as 11½ pounds of superphosphate and 42½ pounds of sulfate of potash, besides a great bulk of soil-improving organic matter. No crop refuse of any kind should be permitted to go to waste within hauling distance of cane fruit plantings. Manure and crop refuse may be used in liberal quantities, ten to twenty tons per acre not being excessive applications.

The Use of Commercial Fertilizers. Certain commercial fertilizers have, in many cases, proved valuable to cane fruits in that they have acted as quick stimulants or accessories to cover crops. Individual instances are reported wherein yields have been increased from 10 to 25 percent by the use of commercial fertilizers. It must be borne in mind, however, that these fertilizers contain nothing essential to plants but what is contained in manure or crop refuse, and, further, that they do but little to improve the physical condition of the soil or promote bacterial and chemical activity. Commercial fertilizers, moreover, when used excessively or when improperly applied, may actually do harm.

Soil authorities are now fairly well agreed that commercial fertilizers produce marked results only when the soil is deficient in the available elements contained by them. Soil abundant in available nitrogen, for example, usually shows but little effect from the application of nitrogenous fertilizers. Further, it is quite certain that commercial fertilizers will have but little effect on soils that are poorly drained, that are compact, or that are too dry. Again, it is clear that actual trial and observation constitute the only method of ascertaining the value of a commercial fertilizer upon a given piece of ground. A chemical test, while valuable in a general way, is of but little specific worth since field conditions cannot be duplicated in the laboratory.

Commercial fertilizer should be thoroughly pulverized before application and should be worked into the soil rather than be allowed to remain on the surface. Some fertilizers are more or less caustic in effect and consequently should not be placed immediately surrounding the plants. The feeding roots of cane fruits extend pretty well across the rows and there is but little danger of placing the fertilizer out of their reach. Some growers find it advantageous to apply their fertilizers as early as February or March.

Kinds of Commercial Fertilizers. Many kinds of commercial fertilizers are now offered for sale. The more common nitrogenous fertilizers are nitrate of soda, sulfate of ammonia, dried blood, and tankage. Phosphorus is contained in such fertilizers as superphosphate, ground bone, Thomas slag, South Carolina rock, and Florida phosphate rock. Muriate of potash, sulfate of potash, and wood ashes are common

potash fertilizers. Sulfur is commonly supplied by ordinary crude sulfur.

By using varying amounts of different plant food elements on different plots, and by observing the results, each grower should be able to determine the kinds and quantities of fertilizers to which his soil responds. Portions of rows of equal length should be measured off, and to these fertilizers both alone and in combination should be applied. One plot, for example, may receive nitrogen, another phosphoric acid, and another potash; while the other plots should receive combinations of these, such as nitrogen and phosphoric acid; nitrogen and potash; phosphoric acid and potash; and phosphoric acid, potash, and nitrogen. Check plots should be left for the purpose of comparison. It is suggested that nitrate of soda or its equivalent be tried at the rate of 200 to 300 pounds per acre. A high grade superphosphate, testing about 16 percent, may be tried at strengths varying between 200 and 400 pounds per acre. Muriate of potash may be applied at from 100 to 150 pounds per acre, while sulfur may be tried at the rate of about 100 pounds per acre.

Effects of Nitrate of Soda on Red Raspberries. Experiments to ascertain the effects of nitrate of soda on the vigor and yields of red raspberries were carried on by the Experiment Station during the seasons of 1919 and 1920. The work was done in the plantation of Mr. Orrin Straton near Brownsville, Oregon. Cane growth in this plantation at the beginning of the experiments was only moderate, indicating that nitrogen was perhaps a limiting factor. The nitrate of soda was applied at the rate of 250 pounds to the acre just as growth was starting in the spring. Check plots were maintained so as to afford a basis of comparison. The results of these experiments were as follows:

		Nitrated plot	*Check plot*
(1)	No. of berries in box	254	270
(2)	Color of berries	Dark pinkish red with luster	Dull pinkish red
(3)	Time of maturity of berries	3 to 5 days earlier	
(4)	No. of new canes to plant	5 to 8	3 to 5
(5)	Average length of new canes	63 in.	59.7 in.
(6)	Color and appearance of foliage	Dark green, vigorous	Lighter green
		Width *Length*	*Width* *Length*
(7)	Average size of leaves	2.95 in. 4.40 in.	2.67 in. 4.10 in.
(8)	Increase in crop 10 percent.		

Obviously in this particular case, beneficial results were obtained from the use of nitrate of soda. Since a considerable portion of Western Oregon soil is known to be deficient in available nitrogen, similar quick results can be expected in many cases by the use of this fertilizer. Whether high production could be maintained indefinitely by this method alone, however, is problematical. The objection has been raised that nitrogenous fertilizers tend to produce berries that are soft in texture and canes that do not properly mature for winter. Experimental data, however, tend to show that this may be overcome in part at least by applying the fertilizer early in spring, by removing the old canes as soon as the crop is harvested and by applying potash and phosphorus along with the nitrate.

Irrigation. Thus far, irrigation has not become a standard practice in this section. There is little doubt, however, that cane fruits would be benefited by irrigation, especially in some seasons. Evergreen black-

berries, in particular, show response to irrigation, and one or two waterings during the dry part of the season do much to increase the tonnage, especially of the later pickings. To permit the ripening of the canes for winter, irrigation should not be practiced late in the year. Each irrigation should be followed by tillage in order that the moisture may be better preserved.

PRUNING AND TRAINING

Though commonly associated together, pruning and training are distinct operations. Pruning deals with the removal of portions of the vine, and training has to do with the disposal of the vine upon the trellis or support. Many systems of pruning and of training are employed in

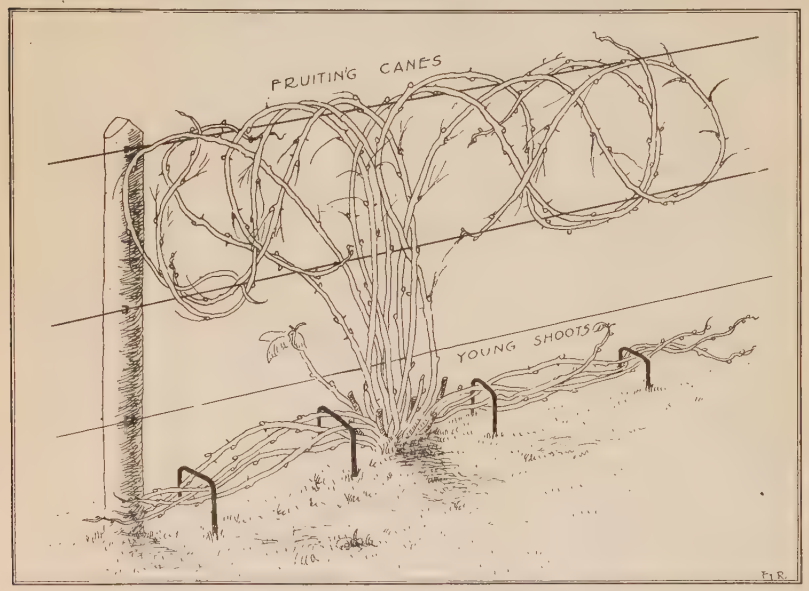

Fig. 2. The weave system of training the loganberry affords a good distribution of the fruiting area and at the same time is convenient for the pickers and tillage implements.

the commercial plantings of cane fruits, and growers are not agreed as to the merits and demerits of each. Obviously, pruning and training systems will continue to vary with individual preference, varieties, planting systems, soil types, and methods of tillage.

The Loganberry. The canes of the loganberry are biennial in character; that is, they grow up from the crowns of the plants one year and die after fruiting the following year. The loganberry does not send up suckers from the roots, and consequently it is not difficult to handle so far as pruning and training are concerned.

In practically all sections loganberry vines are trained to a wire trellis, which is made by setting posts about 30 feet apart in the rows (Fig. 2). Cedar posts when obtainable are very satisfactory for this purpose. The posts should be at least 7 feet in length, 2 to 2½ feet to

be set in the ground. Either two or three wires of number twelve or fourteen size may be used. When three wires are used they are strung along the posts at levels of about 2 feet, 3 feet 9 inches, and 5 feet from the ground. The lower wire, while too low for the accommodation of fruiting wood, aids materially in keeping the bases of the canes in place. When two wires are used they are placed about 2½ and 4½ feet from the ground.

The loganberry is a rather luxuriant grower, and frequently its young shoots are from 18 to 20 feet in length by autumn. If allowed to grow naturally these spread out on the ground in all directions and are in the way of pickers and tillage tools. During the growing season,

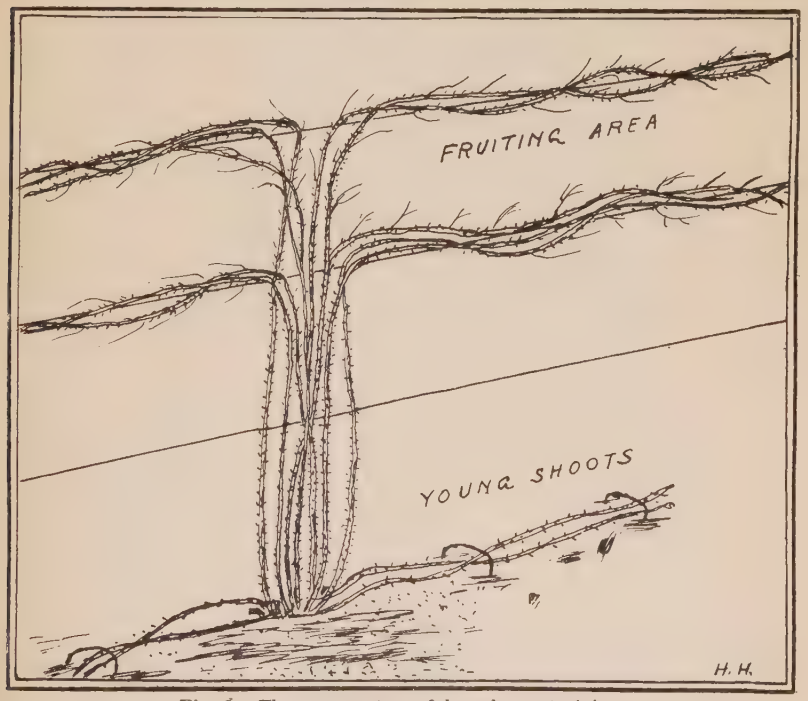

Fig. 3. The rope system of loganberry training.

therefore, they should be trained to run along the rows. Short sticks or wire hooks may be used to keep them in place (Fig. 2), three or four sticks or hooks being sufficient for each plant.

Loganberry canes are usually disposed of on the trellis by either the rope system or by the weave system. When trained by the rope system, the canes are bound together in bundles and then wrapped around the wires (Fig. 3). When the weave system is used, each cane is woven on the wire separately (Fig. 2). Obviously the weave system affords a little more exposure of the canes to the light, and a little more room for the bearing surface. This system seems to be especially adapted to plantations wherein a heavy cane growth is obtained. The rope system seems best adapted to young plantings or to plantations wherein the growth

is more or less limited. Some growers use a combination of the rope and weave systems.

The loganberry may be trellised either in the fall or in the spring. Experimental evidence, however, shows that fall training not only makes possible better control of the cane borer, but tends to eliminate that form of "die back" which is caused by the canes lying on the wet ground, especially when covered with weeds or cover crops. Some growers object to fall training, on the ground that this practice exposes the vines and thus renders them more subject to injury from cold, this belief having been strengthened by the results of the serious freeze which occurred in December of 1919. It must be remembered, however, that this freeze was preceded by an unusually heavy fall of snow which protected the canes that were on the ground. Snow falls of this kind are unusual in Western Oregon and without this snow, loganberry canes would have been almost as much in danger on the ground as upon the trellises.

Ordinarily, very little pruning is necessary in the case of the loganberry. If the canes are healthy and vigorous, they may be trained at full length. Occasionally, when the rope system is used, the canes are so long that they interfere with the next plant, in which case the ends should be shortened somewhat. Frequently canes are produced which are not long enough to be attached to the trellis. These bear but little fruit and may interfere somewhat with the new shoots. All such canes should be removed. Old canes should be taken away as soon as the crop has been harvested. This practice gives the new shoots more air and sunlight and besides, aids materially in keeping down insect pests and diseases.

Red Raspberries. Red raspberries vary considerably in the character of their growth. Canes of Cuthbert, for example, vary from 3 to 15 feet in length, depending primarily upon the nature of the soil and the care received. Obviously no one system of pruning and training is applicable in all cases.

All varieties of red raspberries send up shoots from leader buds, which are usually formed at the base of the one-year-old canes. Sometimes only one such shoot is produced from each cane, but usually two are formed and occasionally three or more appear. Not all of these, however, develop into healthy, vigorous fruiting wood. In addition to the shoots produced from leader buds, red raspberries send up suckers from the roots in large numbers, and unless some system of pruning and training is employed a red raspberry field soon becomes a dense thicket, where numberless canes compete with each other for food, moisture, and light.

In certain eastern cane fruit districts where the hedgerow system of training is used a large percentage of the sucker cane growth is preserved each year for fruiting. The hedgerow system, however, has not been universally successful in Oregon, and instead growers here are employing some form of the linear system, wherein most of the sucker growth is removed and the bearing area is confined primarily to the canes that come from the crowns of the original plants. In this way the plants can be maintained within definite boundaries and cultivation can be done largely by machinery. Besides, a more efficient mulch can be maintained, new cane growth can be better protected, and harvesting is

made considerably easier. The hill system of training developed in New York State is not popular with Oregon red raspberry growers.

Many modifications of the linear system are in use, depending largely upon the nature of the cane growth. Probably the simplest form of this system is that used where the canes are short and stout, in which case the canes hold an erect position without the aid of a trellis. When the cane growth is vigorous and productive, however, this system is inadequate and some form of support for the vines must be provided.

Obviously, any form of trellis used must not only take care of the fruiting area but must protect the young canes and afford convenience for the pickers and general cultural operations. A very efficient trellis

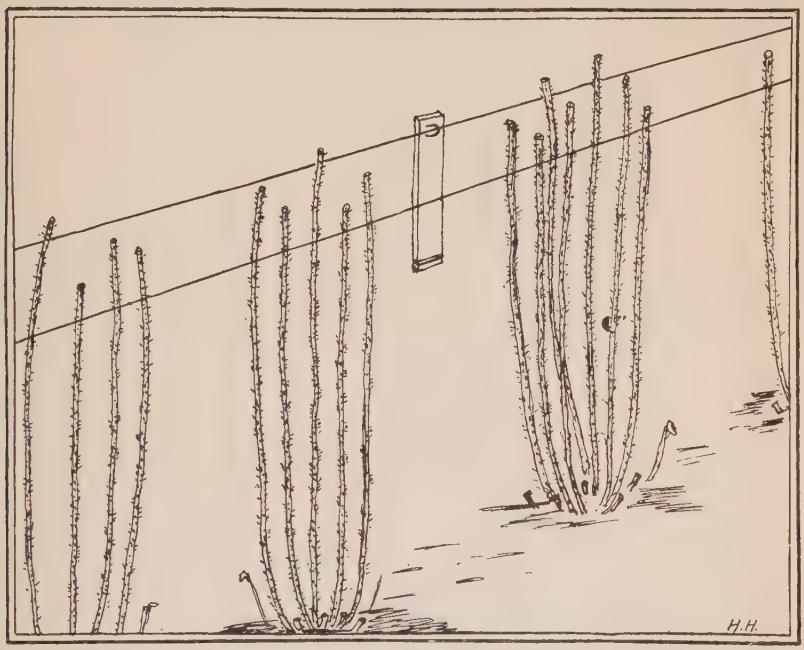

Fig. 4. The fruiting area of red raspberry vines may be lowered by topping the canes from four to four and one-half feet from the ground. The wires afford protection for the young shoots and at the same time keep the fruiting canes within bounds. Note the position of the spreader when not in use.

applicable generally to Oregon conditions can be made by placing posts thirty to thirty-five feet apart and stringing two parallel wires, one on each side of the posts from four to four and one-half feet from the ground (Fig. 4). Number fourteen galvanized iron wire is good for this purpose. If the posts are fairly large in size, cross arms are not necessary. Spreaders for keeping the wires apart during the picking season may be made from one-by-two-inch lumber and should be about fourteen inches in length. These may be kept in place by notches at the ends or by means of staples and hooks (Fig. 5). With a trellis constructed according to this plan the fruiting canes may be tied or woven on the wires, while the young shoots are permitted to grow up between the wires.

In plantations where the canes are tall it is necessary to employ some training system that brings the fruiting area within reach of the pickers. This may be accomplished in one of two ways: first, by topping the canes about four and one-half feet from the ground as shown in Fig. 4; or second, by employing some form of the weave system as represented in Fig. 6. It will be noted that by the latter method most of the cane growth is preserved, while in the former a goodly portion of each cane is removed. Experimental data seem to show that the central part of the cane is the best fruiting portion and that more and better fruit is obtained when it is preserved.

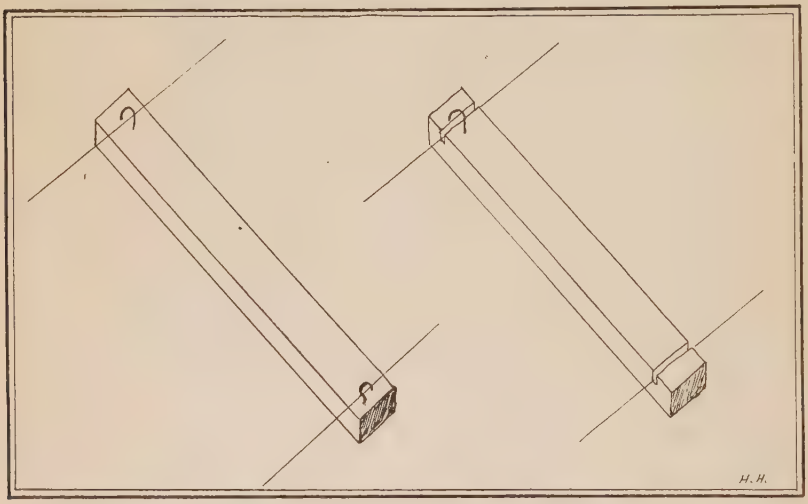

Fig. 5. Two types of spreaders in general use.

Both the single and double weaving methods are employed. When the double method is used the canes are divided so that one-half of them are woven on each wire. The canes are all pulled on the outside of the wires, carried up over the wire and down on the near side. The canes at the ends of the rows should be tied down with string, but after the weave is started no further tying is necessary. An objection to the double weaving method is that some of the berries will come out on the inside and will not be seen by the pickers. This difficulty, however, may be eliminated by using spreaders just before the picking season begins. Weaving should be done in early spring as the canes are less brittle at this time.

When the single weave system is used all the canes are woven on a single wire. The chief objections to this method are that the canes may be overcrowded and that the rows may present an unbalanced appearance.

It is thought best to remove the suckers and excessive canes early during the growing season. The number of canes to leave should vary with the vigor of the plants. Large fruiting areas usually result in more individual berries that are smaller in size but much firmer in texture. The trade in many cases prefers this kind of red raspberries. Good results are generally obtained by leaving from six to twelve canes. Old

canes should be removed as soon as the crop has been harvested. This practice not only aids in the control of insects and diseases, but gives more light and air to the new canes and permits them to mature better for winter.

Black Raspberries. As compared to those of other cane fruits pruning and training of black raspberries are comparatively simple operations. Trellises are not necessary and pruning need not be complicated or excessive.

Black raspberries do not send up suckers from the roots and new growth is confined to the shoots which originate at the crowns of the plants. When the young canes come up in spring they should be allowed

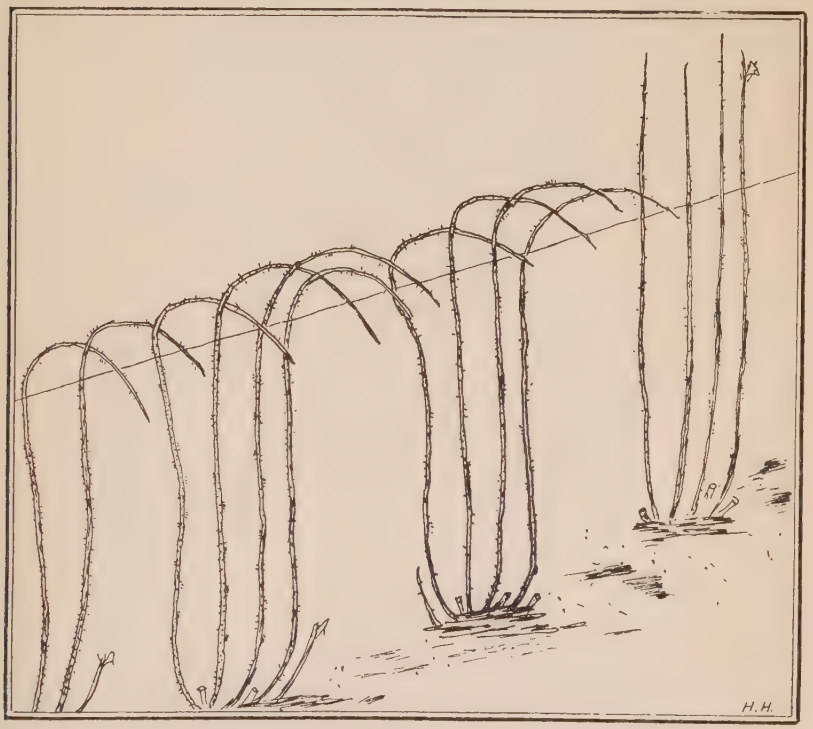

Fig. 6. The fruiting area of red raspberries may also be lowered by the use of the weave system. The double weave, in which half of the canes are woven on each wire with a space in the center for the young shoots to come up through, is now very popular in plantations wherein a heavy cane growth is obtained.

to reach a height of twenty to twenty-four inches and then be topped back to fourteen or sixteen inches. During the rest of the summer, side branches or laterals will develop and the bearing area will thus be increased many fold. Pruning proper should be done in spring just before the buds break open and should consist, first, of thinning out the weaker canes so that the number will be reduced to four or five good vigorous ones, and, second, of thinning and tipping back the laterals. A very

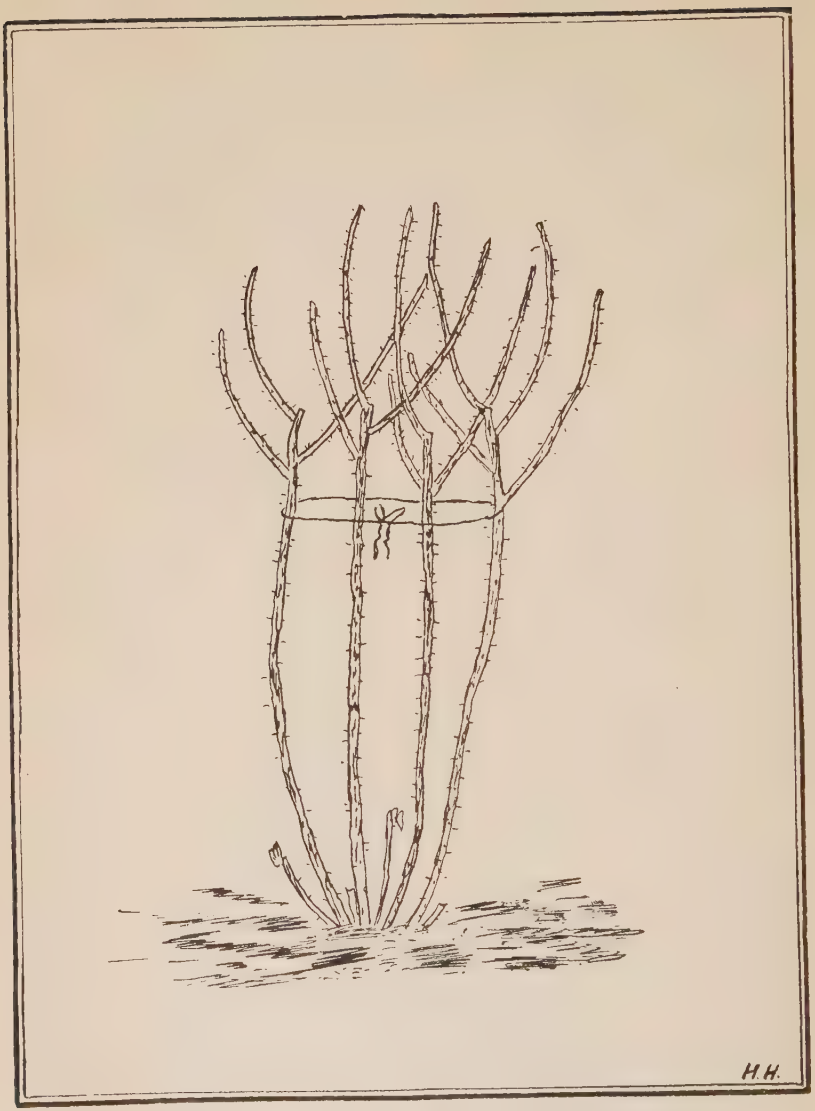

Fig. 7. A convenient and inexpensive method of training the black raspberry.

practical method of training black raspberries consists in tying the laterals up in a rather loose bundle as illustrated in Fig. 7. By this method the fruiting area is placed conveniently for picking and is out of the way of tillage implements. The old canes should be taken out as soon as the crop has been removed.

The Evergreen Blackberry. When once established the Evergreen blackberry is a vigorous grower and unless carefully pruned and trained at regular intervals soon becomes unmanageable. This variety produces shoots from lateral buds at the base of the old canes and also sends up suckers from the roots. Ordinarily it is best to rogue out the suckers and preserve only the canes from the crowns of the plants.

At least four methods of training the Evergreen blackberry are now in use, each method seemingly having its advocates. Some growers train

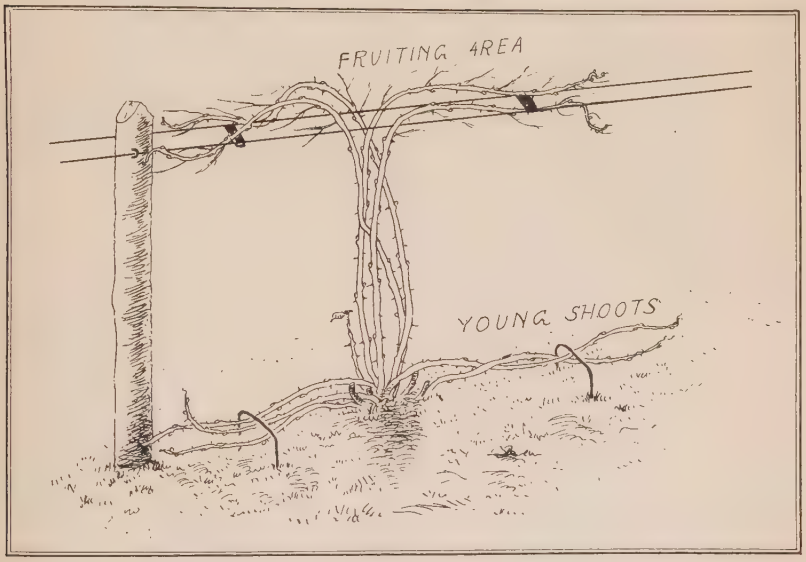

Fig. 8. The two-wire trellis for the Evergreen blackberry is used by some growers.

the Evergreen on very much the same trellis as that used for red raspberries (Fig. 8), the fruiting canes being trained on parallel wires about four feet high and the young shoots being allowed to trail on the ground along the rows. The crop and vines of the Evergreen are unusually heavy and at least a number twelve wire should be used in constructing the trellis. At least one post to every two vines should be used. Spreaders from twenty to twenty-two inches long may be employed to keep the wires apart and to afford leverage and support for the fruiting canes.

Some growers object to the above method because it does not provide protection for the young shoots, which are easily damaged by pickers and tillage implements. This may be remedied, however, by using two extra wires strung about two feet from the ground. Number fourteen wire is amply strong for this purpose. Spreaders fourteen inches

long are sufficient to afford leverage and support for the new growth. In early spring the canes may be transferred to the upper wires.

Some growers, instead of training the new shoots underneath, use a higher post and train them on two wires placed above the fruiting area (Fig. 9). The new growth is carried by these upper wires during the summer months and the following spring is dropped to the lower wires. Experimental data show that by this method the canes ripen up much better for winter and are less subject to injury from cold. The disadvantage of this system is that it is a little hard to get the new growth

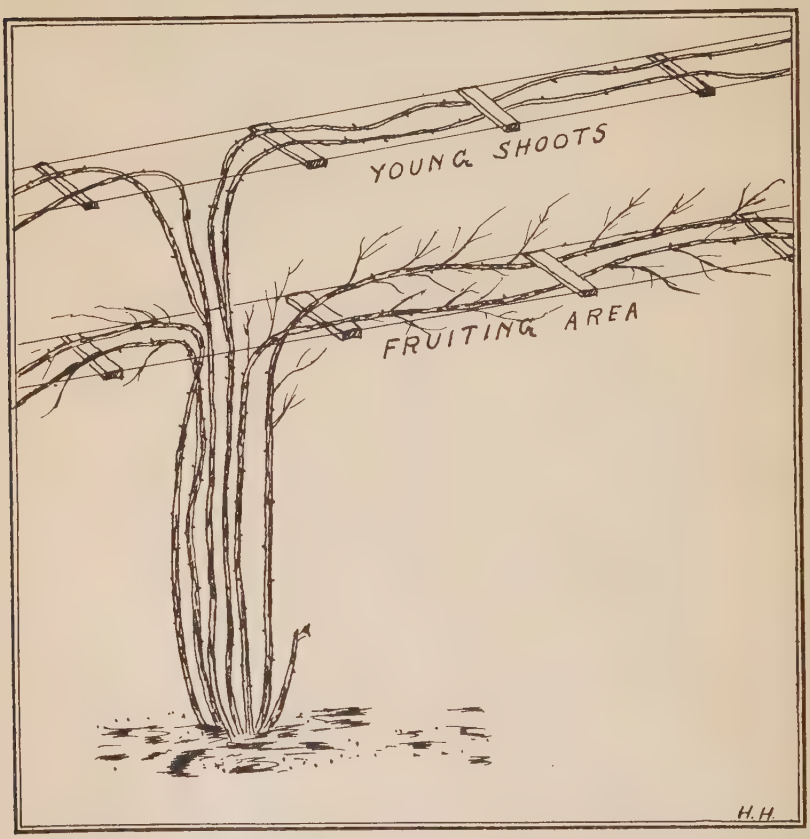

Fig. 9. The overhead system of training the Evergreen blackberry not only affords protection for the young shoots, but permits them to grow in the sunlight where they may mature properly for winter.

through the fruiting area on to the upper wires. On the other hand, however, it is easier to drop the canes to the lower wires in the spring than it is to raise them from the ground or lower wires.

A fourth method employed by a few growers consists in training the new shoots one year on the upper set of wires and the next year on

the lower set. In this way, retraining in the spring is unnecessary, the canes being left in the place where they grew. By this method, however, the fruiting area necessarily alternates from one set of wires to the other, and it is impossible to dispose of it in such a manner that it will be conveniently placed for the pickers every year.

With healthy, vigorous plants from ten to sixteen canes may be preserved for fruiting. Frequently, it is necessary to tip back the canes somewhat so that they will not interfere with each other on the trellis.

HANDLING THE CROP

There is perhaps no operation relating to the growing and marketing of cane fruits that is of more importance than that of handling. The ultimate commercial worth of these fruits is dependent, in a large measure, upon the manner in which the product is harvested and the care it receives from this time until it is processed or consumed. The commercial cane fruit industry, in fact, has been made possible only through the development of efficient and practical methods of picking, hauling, refrigerating, storage, and transportation.

A Fruit is a Living Organism. A fruit, whether attached to the tree or vine, whether in storage or in transit, is a living organism. It carries on life activities and its length of life is determined by environmental as well as internal factors. Consequently, it must be treated as a living thing and not as a mere mass of dead or inert matter.

Fruits Carry on Respiration. Fruits in some respects are like animals. For example, like animals they carry on respiration. They are equipped with respiratory organs and by means of these they take in free oxygen and in turn give off carbon dioxide. It has been shown many times that this exchange of gases is a normal and essential process and that premature death and decay result when it is interfered with to any extent. The relation of this process to handling practices is at once apparent. Fruits during all stages of their life-history must be supplied with abundant fresh air, first to provide the necessary oxygen, and second to carry away the obnoxious gases which accumulate as products of respiration.

Rate of Ripening is Dependent Upon Temperature. It is a matter of common knowledge that the rate of ripening after harvesting is dependent primarily upon the temperature to which the fruit is subjected. The importance of temperature in relation to the rate of ripening is made clear when it is remembered that most fruits ripen from five to eight times as rapidly at 65° F. as they do at 42° F. Of course, the ripening process cannot be entirely stopped at any temperature that will not freeze the fruit, but by prompt and efficient cooling after picking it can be so retarded that the life of the fruit will at least be doubled and so that even such perishable products as raspberries can be shipped great distances or can be held for some time before processing.

Cane fruits as a class are frozen when exposed for a period to temperatures slightly below 30° F. For practical purposes storage temperatures varying between 30° F. and 34° F. are satisfactory. Cane fruits are naturally short lived and consequently should be cooled immediately following removal from the vines. Berries allowed to stand in the hot sun or in a warm packing house undergo rapid deterioration.

The reason for this can be readily understood from the discussion of the relation of temperature to the rate of ripening.

Careful tests show that fruits give up their heat rather reluctantly and that they must be subjected to refrigeration for a considerable time before they are reduced to cold storage temperatures. Berries loaded into properly iced refrigerator cars require from three to four days before they reach a temperature of 50° F. When pre-cooled before loading, however, much less time is required. Berries packed in large, unventilated containers hold their heat much longer than those put up in small, well-ventilated crates. The matter of air circulation through the fruit cannot be over-emphasized in this connection. Berries harvested late in the day after they have been warmed by the sun will give up much of their heat if allowed to stand out-doors during the night, where they may be fully exposed to the cool night air.

Fruits Generate Heat. Fruits may be further compared with animals in that, like animals, they generate heat of their own accord. Gore found that in cases where peaches were confined so that no radiation took place the temperature of the fruit rose from 32° F. to 153° F. in 415 hours. It is evident, therefore, that the matter of self-heating is of considerable importance in the handling of fruits. To eliminate the heat thus produced it is not only imperative that fruit be subjected to cool temperatures but that a good circulation of air be provided at all times, whether fruit is stacked in the field, or in the packing shed, or awaiting processing at the cannery.

Mechanical Injuries Shorten the Life of Fruits. Mechanical injuries due to rough handling materially shorten the life of cane fruits. This is due, first, to the fact that breaks in the skin or covering cause the rate of respiration to be increased. This hastens the life activities with the result that the fruit completes its life-history in a shorter time. Mechanical injuries shorten the life of fruits, in the second place, in that they afford means of entrance for decay organisms. Black and blue molds are serious troubles in all the cane fruit districts of the Pacific Northwest. The spores which cause these diseases are present everywhere. These, however, are saprophytic in character; that is, they do not attack fruit that is sound but follow in the wake of other diseases or injuries. When once they gain an entrance these fungi make rapid progress and in a very short time render the fruit unfit for use. The presence of these diseases is not always apparent to the casual observer, for the black or blue mycelium which characterizes them in the latter stages does not appear until most of the damage to the fruit has been done. Moisture favors the development of molds.

Fruits Should be Handled When Cool. Recent investigations by the United States Department of Agriculture show quite clearly that fruits are much more resistant to mechanical injury when cool than when warm. These investigations showed that cane fruits which had been held in a common ice-box were from 12 to 46 percent more resistant to pressure than the same fruits held at living-room temperature. To take advantage of these findings, cane fruits should be handled only when cool. Picking and hauling whenever possible should be done in the morning while the fruit is still cool from the night temperatures.

Careful Handling Pays. The importance of careful handling of cane fruits is shown by experiments conducted in the Puyallup Valley of Washington a few years ago. Red raspberries that had been carefully harvested and precooled showed only 2.2 percent decay after eight days of storage in refrigerator cars. Fruits handled in the ordinary manner, on the other hand, showed 47.6 percent decay at the end of the same period. By careful handling Pacific Coast blackberries have been successfully shipped as far away as New York City. To avoid as much as possible injury in picking, three fingers always should be used; very few berries should be held in the hand at one time; the berries always should be placed, not dropped, into the basket or cup; all decay-

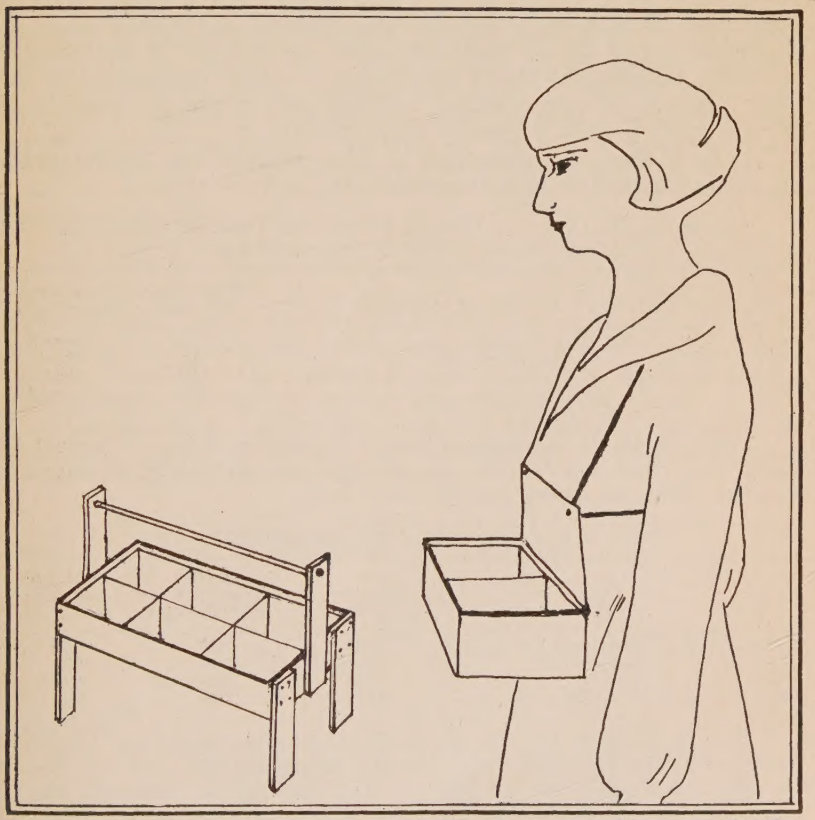

Fig. 10. The waist and hand carriers. A waist carrier supported from the shoulders is not likely to spill when the picker is bending over.

ing, overripe, and injured berries should be discarded; no after handling of the berries in the basket for any purpose should be allowed.

Time of Picking. Time of picking depends primarily upon the use to which the fruit is to be put. It must be borne in mind, however, that cane fruits develop their highest sugar content and best quality when allowed to ripen naturally on the vines.

Loganberries in Oregon begin ripening between June 15 and July 1 and last until August 1 and August 10, depending upon the season and locality. When destined for the fresh fruit market, loganberries should be picked while firm but of good red color. In a properly matured condition they will part from the stems readily and without the necessity of severe pressure from the picker's fingers. When intended for the cannery they should be picked while still firm but after they have thoroughly ripened. While they become sweeter and better flavored if left on the vines until fully ripe, they should not be allowed to become soft as fruit in this condition will break up in processing. Fruit picked as for the fresh fruit trade will make a prettier canned product but will be much more acid than that which has been allowed to ripen two or three days longer. Loganberries for drying purposes should be of good purple color but should not be soft. When intended for juice, loganberries should be allowed to ripen thoroughly on the vines. Berries in this condition not only give a greater quantity of juice but they produce a juice of better quality.

Table II shows the percentage of juice obtained from berries which are underripe, medium ripe, thoroughly ripe, and overripe.

TABLE II. RELATION OF DEGREE OF RIPENESS OF LOGANBERRIES TO THE QUANTITY OF THEIR JUICE*

Sample	Degree of ripeness	Percentage of juice	Rank according to quality
No. 1	Immature	59.3	Fourth
No. 2	Medium ripe	71.8	Third
No. 3	Ripe	71.8	First
No. 4	Overripe	78.1	Second

Table III shows the composition of loganberry juice. It should be noted that when the berries are overripe the percentage of sugar is greatest, while the percentage of acid is least.

TABLE III. COMPOSITION OF LOGANBERRY JUICE

Sample	Degree of ripeness	Specific gravity	Acidity (calculated as sulfuric acid)	Total sugar (calculated as dextrose)
No. 1	Immature	1.032	2.06	3.50
No. 2	Medium ripe	1.0395	2.10	4.91
No. 3	Ripe	1.045	1.88	4.40
No. 4	Overripe	1.040	1.78	6.46

Red raspberries for the fresh fruit market should be harvested when fairly ripe but still firm. For the canneries they may be allowed to ripen thoroughly on the vines. Red raspberries, however, should not be allowed to remain on the vines after maturity, as they ferment readily and soon become worthless.

Black raspberries are less perishable and for all purposes may be allowed to ripen fully before harvesting. In some sections where blackcaps are handled as a dried product they are even allowed to dry on the vines.

*Tables II and III are from Oregon Experiment Station Bulletin 117.

Evergreen blackberries, even though intended for long distance shipping, should be thoroughly ripe at picking time. The small dimple or depression at the apex of each droplet should be completely filled up, this being indication that the berry has attained full size and maturity.

DEHYDRATION

Though most of the cane fruits can be made into dried products, only the loganberry is now dried to any extent in this state. There is ground for belief, however, that as time goes on a greater tonnage of these fruits may be marketed in dehydrated form.

Prune driers are commonly used for the dehydration of loganberries. With driers of the common sort, from 24 to 36 hours are required for drying; but with those of the recirculation type, this time is reduced to as low as 8 to 10 hours. Uusually from 5 to 5½ pounds of the fresh product are necessary to make one pound of dried product, depending somewhat upon the nature of the fruit and the time required for drying. Berries from the uplands dry down less, as a general rule, than those from the lowlands. Crushed or bruised berries dry down more than those that are sound and free from injury.

The berries should be spread on the trays one layer deep. When spread out in this manner, from 12 to 14 pounds of fresh fruit will be required for each tray. If the berries are spread unevenly on the trays some will dry quickly while others will become mushy and dry slowly, making an uneven product. When once on the trays the berries should not be disturbed. Any attempt to pull out stems, flower parts and broken leaves will result in more or less crushing of the fruit.

Table IV shows the effects of high and low temperatures at the beginning of the drying process upon the quantity of dried product obtained and the time required for drying.

TABLE IV. EFFECT OF HIGH AND LOW TEMPERATURES AT THE BEGINNING OF DEHYDRATION

Series	Time of dehydration	Number of pounds of fresh fruit required to make one pound of dehydrated product	Temperature (° F.) Start	Finish
High beginning temperatures				
No. 1	23 hrs. 35 min.	5.2	140	150
No. 2	14 hrs. 22 min.	4.8	160	160
No. 3	16 hrs. 30 min.	4.5	160	160
No. 4	16 hrs.	3.9	150	150
Average	17 hrs. 37 min.	4.6	131	155
Low beginning temperatures				
No. 1	38 hrs. 25 min.	5.5	100	150
No. 2	31 hrs. 55 min.	5.6	90	155
No. 3	28 hrs. 48 min.	5.3	96	150
Average	33 hrs. 3 min.	5.5	95.3	151.6

Obviously when the fruit is subjected to comparatively high temperatures at the beginning of the drying process, a higher percentage of dried product is obtained and the time of drying is reduced considerably. Moreover, a product of higher quality is obtained. The berries keep their form better and have better color. Evidently high heat at the start sears over the berries and prevents the loss of juice which it is desirable to retain. For practical purposes a beginning temperature of 135° F. to 140° F. is not too high. The finishing temperature should be between 150° F. and 160° F.

The berries should be removed from the drier while still somewhat soft as they have a tendency to harden when cooled. To prevent slicking they should be taken from the trays before they become cool. They should be left on the table only long enough to cool. This is especially important at night, for it is then that certain moths deposit their eggs. These eggs hatch in a short time and the larvae feed on the dried fruit. As these moths fly only at night and work only on the fruit which is near a light, a little care will aid materially in preventing wormy fruit.

After removal from the trays the berries should be stored, preferably in bulk in a clean, dark room. If piled about 2½ feet deep and turned over with a fork or shovel every few days, they will go through a "sweating" process which equalizes the moisture content and insures a uniform product.

Note: For information on the insect pests and diseases of the cane fruits see Ore. Sta. Cir. 45.